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MEASUREMENT OF TRUE ILEAL CALCIUM DIGESTIBILITY OF FEED INGREDIENTS FOR BROILER CHICKENS

A thesis presented in partial fulfilment of the requirements for the degree of
Doctor of Philosophy in
Animal Science
at Institute of Veterinary, Animal and Biomedical Science (IVABS)
Massey University, Palmerston North,
New Zealand

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2017

ABSTRACT

The recent interest towards the use of digestible phosphorus (P) in poultry feed formulations necessitates the measurement of true calcium (Ca) digestibility of feed ingredients because of the close relationship between these two minerals for their absorption and post absorptive utilisation. When this thesis research was initiated, no published data were available on Ca digestibility of feed ingredients for broiler chickens. The major objective of the studies reported in this thesis was to determine the true Ca digestibility of feed ingredients for broiler chickens. In total, nine studies were conducted.

The first study (Chapter 4) was conducted to determine the effect of methodology on ileal endogenous Ca losses. Three methods, namely feeding a Ca- and P-free diet, maize gluten meal based diet and egg albumen based diet, were used. Ileal endogenous Ca losses differed among different methodologies. The highest ileal endogenous losses of 125 mg/kg dry matter intake (DMI) were recorded on the Ca- and P-free diet, followed by 77 and 43 mg/kg DMI on maize gluten meal and egg albumen diets, respectively.

In the second and third studies (Chapters 5 and 6), regression and direct methods, respectively, were used to determine the true Ca digestibility of meat and bone meal (MBM). The true Ca digestibility coefficient of MBM samples were ranged from 0.41 to 0.60. No difference was observed between true Ca digestibility coefficients of MBM determined by regression and direct methods. Since the direct method is less laborious and cost effective compared to regression method, this method was used in subsequent studies (Chapters 7 to 10) to determine the true Ca digestibility of a range of Ca sources.

In fourth and fifth studies (Chapters 7 and 8), the influence of dietary P, particle size and Ca to non-phytate P ratio was investigated on the true Ca digestibility of limestone for broiler chickens. The true Ca digestibility of three limestone samples varied from 0.56 to 0.62. Supplementation with recommended dietary P (4.5 g/kg) increased the true Ca digestibility of limestone when compared to diets without P. An increase in particle size from <0.5 to 1-2mm improved the true ileal Ca digestibility of

limestone. Widening the Ca to non-phytate P ratio reduced the true Ca digestibility of limestone for broiler chickens.

The sixth study (Chapter 9) was conducted to determine the effect of Ca source and particle size on the true Ca digestibility and total tract retention. Limestone and oyster shell were used as Ca sources. No difference was observed between the true Ca digestibility of limestone and oyster shell. An increase in particle size from <0.5 to 1-2 mm increased both the Ca digestibility and retention of both Ca sources, and increased the Ca concentration of gizzard contents.

The study reported in Chapter 10 was conducted to determine the true Ca digestibility of dicalcium phosphate (DCP), monocalcium phosphate (MCP), canola meal, poultry by-product meal and fish meal, and to compare the effect of dietary adaptation length on true Ca digestibility of DCP and MCP. The true Ca digestibility coefficients of these feed ingredients were lower than MBM, limestone and oyster shell, and ranged from 0.24 to 0.33. It was speculated that the length of adaption to the assay diets may be responsible for the lower than expected estimates. The effect of dietary adaptation length (24, 48 or 72 hrs) was subsequently examined, but had no effect on true Ca digestibility of DCP and MCP.

In the final study (Chapter 11), the true Ca digestibility of DCP was determined using different methodologies (regression, difference and direct methods). The true Ca digestibility coefficients of DCP were 0.34 and 0.21 with direct and different methods, respectively. A very low digestibility coefficient of 0.13 was determined by the regression method.

In conclusion, the true Ca digestibility coefficient of major Ca sources (limestone, oyster shell and MBM) is not high and varied from 0.40 to 0.70. Particle size of limestone and oyster shell influenced Ca digestibility, with coarser particles having higher digestibility. The direct method appears to be suitable for the determination of true Ca digestibility of limestone, oyster shell and MBM, but may not be appropriate for other Ca sources with intrinsic imbalance of Ca and P.

Acknowledgements

First of all, I would like to express my deepest gratitude to my major supervisor Professor Ravi Ravindran for his patience, constructive ideas and guidance in planning and conduct of studies and thesis writing. It was really an honour for me to work with such an amazing person and one of the best poultry nutritionist in the world. For me, completion would have been an impossible goal without the help of Professor Ravindran.

I am immensely thankful to my co-supervisors, Dr Rana Ravindran, Professor Patrick Morel and Professor Aaron Cowieson for guiding me in every step of my research and writing process. Their support and guidance was helpful to complete my journey of Ph.D.

I appreciate the help and support of staff at the Poultry Research Centre, especially to Don Thomas, Colin Naftel, Edward James and Shaun de Malmanche for their technical support and assistance in diet mixing, conduct of studies and help in sample collections. I am thankful to Fliss Jackson and the laboratory staff at the Nutrition lab, and Food Chemistry laboratory for their assistance in the analysis of samples.

I am really thankful to HEC (Higher Education Commission of Pakistan) for giving me this scholarship to provide financial assistance for my studies. I really appreciate the Claude McCarthy Fellowship New Zealand that sponsored me to present my research work in 20th European Symposium on Poultry Nutrition, 2015 in Prague and 25th World Poultry Congress, 2016 in Beijing.

I appreciate the help and guidance of my colleagues and friends from Massey University, especially Reza Abdollahi, Fifi Zaefarian, Ruvini Mutucumarana, Nipuna and Khaldoun, for guidance and encouragement during my study.

It was a dream of my late father Muhammad Anwar that I should get a doctorate degree from abroad. He struggled throughout his life to provide motivation and good education to us. I have no words to express my feelings for my Mother Balkees Anwar who always remembers me in her prayers and I know that it was impossible to achieve this goal without her prayers. I am thankful to my brothers, sisters and cousins for

supporting and encouraging me to attain this goal. Especially my elder brothers, Hafeez Anwar and Shakeel Anwar for their support and the way they tried to fill the gap left by my late Father.

Finally big thanks to my wife Huma, my daughter Aleesha and my son Arham who were with me in New Zealand and supported me to achieve this milestone. They suffered a lot because of my busy schedule during the PhD programme.

Publications

Studies completed during candidature, some of which are reported in this thesis have been presented in the following communications:

Referred scientific papers

Anwar, M. N., Ravindran, V., Morel, P. C. H., Ravindran, G. and Cowieson, A. J. (2017). Effect of calcium source and particle size on the true ileal digestibility and total tract retention of calcium in broiler chickens. *Animal Feed Science and Technology*, **224**:39-45.

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List of Abbreviations

%	Percent
µg	Micro gram
µl	Micro litre
1, 25-(OH) ₂ D ₃	1, 25-dihydroxycholecalciferol
AAFCO	Association of American Feed Control Officials
AIDC	Apparent ileal digestibility coefficient
ANOVA	Analysis of variance
AOAC	Association of Official Analytical Chemists
Ca	Calcium
Ca _E	Calcium in excreta
Ca _I	Calcium in diet
Ca _O	Calcium in digesta
CM	Canola meal
CO ₂	Carbon dioxide
CP	Crude protein
CT	Calcitonin
Cu	Copper
DCP	Dicalcium phosphate
DM	Dry matter
DMI	Dry matter intake
Fe	Iron
FM	Fish meal
g	Gram
g/b/d	Gram per bird per day
GLM	General linear model
GMD	Geometric mean diameter
GSD	Geometric standard deviation

H ₂ O	Water
HCl	Hydrochloric acid
I	Iodine
IECaL	Ileal endogenous calcium losses
IU	International unit
kg	Kilogram
M	Molar
MBM	Meat and bone meal
MCP	Monocalcium phosphate
mg	Milligram
MJ	Mega joule
mm	Millimetre
Mn	Manganese
Mo	Molybdenum
N	Nitrogen
N ₂	Nitrogen gas
NRC	National Research Council
NS	Non-significant
O ₂	Oxygen
°C	Degree centigrade
P	Phosphorus
<i>P</i>	Probability
PBPM	Poultry by-product meal
PTH	Parathyroid hormone
SAS	Statistical analysis software
SE	Standard error
Se	Selenium
SEM	Standard error of mean
Ti	Titanium dioxide

TIDC	True ileal digestibility coefficient
Ti _E	Titanium dioxide in excreta
Ti _I	Titanium dioxide in diet
Ti _O	Titanium dioxide in digesta
UV	Ultra violet
WPSA	World's Poultry Science Association
Zn	Zinc